CLAIMS

1. A method for controlling the injection of reducing agent upstream from a catalyst (4) in an exhaust line (2) from a combustion engine (1), **characterised** in
- that an accumulation actual value (*A1*) representative of the current accumulation in the catalyst (4) of a reducing substance forming part of or formed by the reducing agent is calculated on the basis of information from a computation model which, taking into account the expected reactions in the catalyst under prevailing operating conditions, continuously determines the current state of the catalyst, e.g. the accumulation of the reducing substance in different parts of the catalyst and the conversion of exhaust gas substance taking place in different parts of the catalyst,
- that an accumulation setpoint value (*A2*) is calculated on the basis of an emission setpoint value (*E2*) and information from said computation model, whereby the emission setpoint value (*E2*) is representative of a desired content, in the exhaust gases leaving the catalyst (4), of an exhaust gas substance which, as the exhaust gases pass through the catalyst, is at least partly removed from the exhaust gases by the action of the reducing substance or formed by the action of the reducing substance, and the accumulation setpoint value (*A2*) is representative of the reducing substance accumulation required in the catalyst under prevailing operating conditions for substantially achieving the emission setpoint value (*E2*),
- that the accumulation actual value (*A1*) is compared with the accumulation setpoint value (*A2*), and
- that the injection of reducing agent in the exhaust line is controlled on the basis of the result of the comparison between the accumulation actual value (*A1*) and the accumulation setpoint value (*A2*).

2. A method according to claim 1, **characterised** in that a limitation factor ($f_{constrain}$) is calculated, which limitation factor has a value which depends on an estimate of the current risk

that the reducing substance content of the exhaust gases leaving the catalyst might exceed a predetermined limit value, and in that this limitation factor is taken into account in calculating the accumulation setpoint value (*A2*) in such a way that the accumulation setpoint value (*A2*) decreases in response to increasing risk that the reducing substance content of the exhaust gases leaving the catalyst might exceed the predetermined limit value.

3. A method according to claim 2, **characterised** in that the limitation factor ($f_{constrain}$) is used as a multiplication factor in calculating the accumulation setpoint value (*A2*) and is given a value which varies between 0 and 1 depending on the current risk that the reducing substance content of the exhaust gases leaving the catalyst might exceed the predetermined limit value, whereby the value of the limitation factor is close to 1 when there is no such risk and close to 0 when such risk is imminent.

4. A method according to claim 1, **characterised** in that the NO_x conversion capacity of the catalyst under prevailing operating conditions is calculated on the basis of information from said computation model and is taken into account in calculating the accumulation setpoint value (*A2*).

5. A method according to any one of the foregoing claims, **characterised** in that the accumulation actual value (*A1*) and the accumulation setpoint value (*A2*) are supplied to a first comparator (32), which emits to a first regulator (34), preferably in the form of a PI regulator, a signal (*S1*) which depends on the conformity between the accumulation actual value (*A1*) and the accumulation setpoint value (*A2*), and that the regulator (34) emits on the basis of the signal from the comparator (32) a control signal (*S2*), whereby the injection of reducing agent in the exhaust line is controlled on the basis of that control signal (*S2*).

6. A method according to any one of the foregoing claims, **characterised** in
   - that an emission actual value (*E1*) is determined by calculation or measurement, which emission actual value (*E1*) is representative of the current content of the exhaust gas substance in the exhaust gases leaving the catalyst (4),
   - that the emission actual value (*E1*) is compared with the emission setpoint value (*E2*), and
   - that the accumulation setpoint value (*A2*) is calculated on the basis of information from said computation model and the conformity between the emission actual value (*E1*) and the emission setpoint value (*E2*).

7. A method according to claim 6, **characterised** in that the emission actual value (*E1*) is calculated by means of said computation model or on the basis of information from said computation model.

8. A method according to claim 6 or 7, **characterised** in that the emission actual value (*E1*) and the emission setpoint value (*E2*) are supplied to a second comparator (42) which emits to a second regulator (44), preferably in the form of a PI regulator, a signal (*S3*) which depends on the conformity between the emission actual value (*E1*) and the emission setpoint value (*E2*), and that the second regulator (44) emits on the basis of the signal from the second comparator (42) a control signal (f_{SP}) which is caused to affect the calculation of the accumulation setpoint value (*A2*).

9. A method according to any one of claims 6-8, **characterised** in that the accumulation setpoint value (*A2*) is obtained by multiplication of two multiplication factors, whereby a first multiplication factor takes the form of a calculated accumulation maximum value (A_{max}) which is representative of the maximum permissible reducing substance accumulation in the catalyst under prevailing operating conditions, and a second multiplication factor depends on the conformity

between the emission actual value ($E1$) and the emission setpoint value ($E2$).

10. A method according to any one of the foregoing claims, **characterised** in that, according to the computation model, the catalyst (4) is divided in its longitudinal direction into a multiplicity of segments, whereby the accumulation actual value ($A1$) and the accumulation setpoint value ($A2$) refer respectively to current and required reducing substance accumulation in the segment situated nearest to the inlet end of the catalyst.

11. A method according to claim 9, **characterised** in that, according to the computation model, the catalyst (4) is divided in its longitudinal direction into a multiplicity of segments, and that the accumulation maximum value (A_{max}) refers to the maximum permissible reducing substance accumulation under prevailing operating conditions in the segment situated nearest to the inlet end of the catalyst.

12. A method according to claim 9 or 11, **characterised** in that a limitation factor ($f_{constrain}$) is calculated, which limitation factor ($f_{constrain}$) has a value which depends on an estimate of the current risk that the reducing substance content in the exhaust gases leaving the catalyst might exceed a predetermined limit value, and in that this limitation factor ($f_{constrain}$) is taken into account in calculating the accumulation maximum value (A_{max}) in such a way that the accumulation maximum value (A_{max}) decreases in response to increasing risk that the reducing substance content of the exhaust gases leaving the catalyst might exceed the predetermined limit value.

13. A method according to claim 12, **characterised** in that the limitation factor ($f_{constrain}$) is used as a multiplication factor in calculating the accumulation setpoint value (A_{max}) and is given a value which varies between 0 and 1 depending on the

current risk that the reducing substance content of the exhaust gases leaving the catalyst might exceed the predetermined limit value, whereby the value of the limitation factor is close to 1 when there is no such risk and close to 0 when such risk is imminent.

14. A method according to claim 9, **characterised** in
- that, according to the computation model, the catalyst (4) is divided in its longitudinal direction into a multiplicity of segments,
- that for each of the segments of the computation model an accumulation value (A_k) and a conversion value ($R_{max,k}$) are calculated, whereby the accumulation value (A_k) is representative of the maximum permissible reducing substance accumulation in the segment under prevailing operating conditions, and the conversion value ($R_{max,k}$) is representative of the expected conversion of the exhaust gas substance in the segment when the reducing substance accumulation in the segment corresponds to the accumulation value,
- that the conversion values ($R_{max,k}$) for the various segments are summated, and
- that the resulting sum is converted to a fictitious value for the maximum permissible reducing substance accumulation in the segment situated nearest to the inlet end of the catalyst, whereby this fictitious value constitutes said accumulation maximum value (A_{max}).

15. A method according to claim 14, **characterised** in that for each of the segments a limitation factor ($f_{constrain,k}$) is calculated, which limitation factor has a value which depends on an estimate of the current risk that the reducing substance content of the exhaust gases leaving the catalyst might exceed a predetermined limit value, and that this limitation factor ($f_{constrain,k}$) is taken into account in calculating the conversion values ($R_{max,k}$) in such a way that the conversion values ($R_{max,k}$) decrease in response to increasing risk that the

reducing substance content of the exhaust gases leaving the catalyst might exceed the predetermined limit value.

16. A method according to claim 15, **characterised** in that the limitation factor ($f_{constrain,k}$) is used as a multiplication factor in calculating the conversion value ($R_{max,k}$) and is given a value which varies between 0 and 1 depending on the current risk of the reducing substance content of the exhaust gases leaving the catalyst might exceed the predetermined limit value, whereby the value of the limitation factor is close to 1 when there is no such risk and close to 0 when such risk is imminent.

17. A method according to any one of claims 14-16, **characterised** in
- that for each of the segments a value (R_k) is calculated for the current conversion of the exhaust gas substance in the segment,
- that a value (R_{tot}) for the total current conversion of the exhaust gas substance in the catalyst (4) is calculated by summation of the values (R_k) of the various segments, and
- that the value (R_{tot}) for the total current conversion of the exhaust gas substance in the catalyst is converted to a fictitious value of the current reducing substance accumulation in the segment situated nearest to the inlet end of the catalyst, whereby this fictitious value constitutes the accumulation actual value ($A1$).

18. A method according to any one of the foregoing claims, **characterised** in that the emission setpoint value ($E2$) is calculated on the basis of prevailing operating conditions.

19. A method according to any one of the foregoing claims, **characterised** in that at least the following parameters are used in the computation model when generating information for the calculation of the accumulation actual value ($A1$) and the accumulation setpoint value ($A2$):

- the exhaust gas temperature (*P1*) upstream from the catalyst,
- the concentration (*P2*) of the exhaust gas substance in the exhaust gases upstream from the catalyst,
- the exhaust mass flow (*P3*) through the catalyst, and
- the amount (*P4*) of reducing agent injected.

20. A method according to any one of the foregoing claims, **characterised** in that urea or ammonia is used as reducing agent, whereby the reducing substance takes the form of ammonia.

21. A method according to any one of the foregoing claims, **characterised** in that the exhaust gas substance takes the form of NO_x.

22. A device for utilising a method according to any one of claims 1-21 for controlling the injection of reducing agent upstream from a catalyst (4) in an exhaust line (2) from a combustion engine (1), **characterised** in that the device comprises
- a first computation means (20) adapted to determining continuously, by using a computation model, the current state of the catalyst, taking into account the expected reactions in the catalyst under prevailing operating conditions,
- a second computation means (30) adapted to calculating, on the basis of information from said computation model, an accumulation actual value (*A1*) representative of the current accumulation in the catalyst (4) of a reducing substance forming part of or formed by the reducing agent, whereby the second computation means (30) is likewise adapted to calculating, on the basis of an emission setpoint value (*E2*) and information from said computation model, an accumulation setpoint value (*A2*), whereby the emission setpoint value (*E2*) is representative of a desired content, in the exhaust gases leaving the catalyst (4), of an exhaust gas substance which, as the exhaust gases pass through the catalyst, is at least partly removed from the exhaust gases by

the action of the reducing substance or is formed by the action of the reducing substance, and the accumulation setpoint value (*A2*) is representative of the reducing substance accumulation required in the catalyst under prevailing operating conditions in order for substantially achieving the emission setpoint value (*E2*),

- a comparator (32) adapted to comparing the accumulation actual value (*A1*) and the accumulation setpoint value (*A2*), and
- regulating means (34, 36) for controlling the injection of reducing agent on the basis of comparison between the accumulation actual value (*A1*) and the accumulation setpoint value (*A2*).

23. A device according to claim 22, **characterised** in that the device comprises means for determining by calculation or measurement an emission actual value (*E1*) representative of the current content of the exhaust gas substance in the exhaust gases leaving the catalyst (4), and that the second computation means (30) is adapted to calculating the accumulation setpoint value (*A2*) on the basis of information from said computation model and the conformity between the emission actual value (*E1*) and the emission setpoint value (*E2*).

24. A computer program directly loadable to the internal memory of a computer, which computer program comprises program codes for implementing a method according to any one of claims 1-21.

25. A computer program product comprising a medium which is readable by an electronic control unit and has stored on it a computer program intended to cause an electronic control unit to implement a method according to any one of claims 1-21.

26. An electronic control unit (50) comprising an execution means (51), a memory (53) connected to the execution means (51),

and a storage medium (54) connected to the execution means, whereby a computer program comprising program code for implementing a method according to any one of claims 1-21 is stored in said storage medium (54).